European Commission

JRC SCIENTIFIC AND POLICY REPORTS

ERAWATCH COUNTRY REPORTS 2011: Luxembourg

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2013

Report EUR 25723 EN

Joint Research Centre

European Commission
Joint Research Centre
Institute for Prospective Technological Studies

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JRC77766

EUR 25723 EN

ISBN 978-92-79-28126-6 (pdf)

ISSN 1831-9424 (online)

doi:10.2791/55247
Luxembourg: Publications Office of the European Union, 2013

Printed in Spain

Acknowledgements and further information:

This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). ERAWATCH is a joint initiative of the European Commission's Directorate General for Research and Innovation and Joint Research Centre.

The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl. The report has been produced by the ERAWATCH Network under contract to JRC-IPTS. The first draft of this report was produced in November 2011 and is focused on developments taking place in the previous twelve months.

In particular, it has benefited from comments and suggestions of Patrick Eparvier, who reviewed the draft report. The contributions and comments of Carat Gerard from JRC-IPTS and DG-RTD are also gratefully acknowledged.

The report is currently only published in electronic format and available on the ERAWATCH website. Comments on this report are welcome and should be addressed to jrc-ipts-erawatch-helpdesk@ec.europa.eu.

Executive Summary

Luxembourg is small in size and has a young public research system. Its public research institutions are only slightly more than two decades old and its sole university was formed as recently as 2003. Because of these factors, Luxembourg's national research system (NRS) remains relatively straightforward, with the Ministry of Higher Education and Research (MESR) heading the National Research Fund (NRF), the University and the public research organisations. The Ministry of the Economy and Foreign Trade (MECE) supports private sector research and also contains an IP Office. Luxinnovation bridges the public and private sectors, while a governmental Superior Committee for Research and Innovation ensures consistency and coherency in the research policy mix.

At a provisional 1.63% of GDP in 2010, Luxembourg's GERD l lags the EU-27 average of 2.0%; this deficit reflects the Grand Duchy's need to develop more absorptive capacity. The government's GERD targets for 2020 are between 1.5-1.9% of GDP for private sector R&D expenditures and 0.7-0.8% of GDP for public sector R&D expenditures. An intermediate target of 2.0% of GDP overall has been set for 2015. The estimate of government investment in RDI is €247.7m, or 0.60% of GDP for 2010 and €258.3m, or 0.58%, of GDP, for 2011.

Positioning Luxembourg in the midst of the Eurozone crisis, the Grand Duchy had the lowest deficit in GDP % terms in 2010 and remains one of the lowest in 2011. This suggests that RDI budget commitments will continue to be met, as they were during the "Great Recession" of 2008-2009.

Luxembourg's national RDI strategy is founded on multi-annual planning and focuses on targeted priorities. It continues a process begun by an OECD review of Luxembourg's NRS in 2006 and a Foresight Study in 2006-2007 that identified the thematic domains which make up the CORE public research funding programme. A major result of the OECD review was the recommendation to implement performance contracts between the MESR and the NRF, the University, the public research institutions and Luxinnovation. A second set of contracts has been executed for the period of 2011-2013, following the initial set for 2008-2010.

The National Reform Plan (NRP) for 2011, *Luxembourg 2020*, identifies biohealth, eco-technologies and logistics as three priority areas for RDI. It sets a target of 240 projects to be funded under the law of 5 June 2009, which provides support for private sector RDI, and looks towards the completion of the massive, €565 million infrastructure project, Cité des sciences that will house the University and three public research organisations, as well as provide facilities for public-private partnerships and a business incubator.

Structural challenges for Luxembourg's NRS have been identified as:

- **Increasing absorptive capacity**. Policies are in place but an increase also depends on economic conditions.
- **Increasing Luxembourg's research profile through international cooperation**. To gain critical mass in its targeted priorities, Luxembourg needs greater participation in international consortia. An indicator is Luxembourg's relatively low participation in FP7 projects.

- **Developing human resources in RDI**. Luxembourg relies heavily on foreign researchers to staff its NRS. More native researchers are needed. Luxembourg is also at the bottom ranks of the EU in gender equality and has no policies to specifically address the issue.
- **Developing a culture of evaluation**. The MESR mandates evaluations of PROs; organisations need to react more effectively to the resulting recommendations.
- **Promoting a culture of entrepreneurship.** A dearth of entrepreneurial spirit, as well as difficulties in launching a start-up in the Grand Duchy, has long been identified in ERAWATCH and TrendChart reports. While support measures exist, a change in societal attitudes towards entrepreneurship as a career choice is also needed.

How well Luxembourg's priorities match its structural challenges varies. Luxembourg does have measures in place to increase its *absorptive capacity* over time, including the law of 5 June 2009 and the requirement that PROs generate revenue from working with the private sector. Performance contracts also mandate revenues from international projects. These should help *increase Luxembourg's research profile,* as should the Fit4Europe initiative for the private sector. The need for increased participation is also recognised in the 2011 NRP and a target established. Solutions are being sought on how to deal with the burden of project administration.

Luxembourg's extensive support for PhDs and post-docs through the Aid for Research Training (AFR) programme, its PEARL and ATTRACT programmes, and its promoting research as a career will assist in the *development of human resources* in RDI. The issue of gender equality requires a more active approach.

Finally, *developing cultures of evaluation and entrepreneurship* both enjoy supportive policies. Entrepreneurship especially benefits from provisions in the law of 5 June 2009, the law giving beneficial tax treatment to IP revenue, the availability of business incubators with a range of expert support services and the resources of Luxinnovation. PRO performance contracts also have targets requiring the valorisation of research and creation of spin-offs. For both entrepreneurship and evaluation, however, changes in mind-set are also needed, which are harder to address through policy alone.

In terms of its *RDI policy mix*, Luxembourg's has been consistent and coherent in focussing on targeted research priorities and undertaking multi-annual planning. Since an OECD review of Luxembourg's innovation system in 2006, the RDI policy mix has broadened to include the main OECD recommendations. A Foresight Study undertaken in 2006-2007 resulted in the CORE programme, which focuses on the thematic domains identified by the Foresight exercise. The most important development has been the instituting of performance contracts with major NRS actors in the public sector and the law of 5 June 2009 for government support of RDI activities in the private sector.

Examining the policy mix using categories from the ERAWATCH Research Inventory 2010, *fiscal policies* were enhanced with the law on research subsidies and its focus on SMEs and services sector innovation. *Human resource policies* benefited from the ATTRACT and PEARL programmes, which bring external researchers to undertake projects in Luxembourg PROs, while the AFR programme expanded to fund more than 600 PhDs and post-docs since 2008 and mandated that beneficiaries be given

work contracts and social benefits while pursuing their research. Finally, policies to increase *knowledge triangle interaction* were part of performance contract requirements for external revenues, including contract work and public private partnerships. A push to complete the Cité des sciences infrastructure project will also result in synergies between knowledge triangle actors.

Luxembourg's policies widely support ERA objectives. With 43% of its population made up of foreign residents and nearly half of its workforce commuting across borders with neighbouring Belgium, France and Germany, Luxembourg is a model of researcher mobility, with researchers enjoying standard work contracts and full social benefits. Luxembourg recognises the need for knowledge circulation and cross border cooperation and has agreements with other national and international agencies in place as well as programmes to fund project participation. Performance contracts require revenues from international sources while Fit4Europe helps support businesses submit FP7 and ESA proposals. Public-private partnerships that will help increase absorptive capacity are encouraged through a variety of measures, including performance contract targets.

In the near-term, the focus of Luxembourg's NRS will include how well PROs fulfil their 2011-2013 performance contract requirements, including participation in international projects and attracting private sector research partners, how well the AFR programme develops human resources in the form of PhDs and post-docs and how the Cité des sciences project progresses. In the private sector, demand for support measures from the law of 5 June 2009 can be expected to be impacted by decreases in BERD, which has fallen from 1.43% of GDP in 2006 to a provisional 1.16% in 2010.

Medium-term, projects and researchers funded by the PEARL and ATTRACT programmes will be completed and the results assessed. Research priorities in biohealth, eco-technologies and logistics will also have developed to the point that undertakings can be assessed and adjustments to provisions made if required. Additional expectations include the achievement of substantive work on societal challenges such as ageing and diversity and integration, which are CORE programme themes, as well as meeting the government's target of 2% of GDP investment overall in RDI by 2015. Achieving this latter goal may be more challenging than initially anticipated as the Eurozone crisis impacts GDP growth. Already Luxembourg's 2011 GDP has been revised downward to +1.1%, lower than the forecast Eurozone average of +1.5%, and 2012 estimates have been lowered to 0.7% from 1.0%. At the same time, BERD has also been dropping, from 1.43% in 2006 to a provisional 1.16% in 2010. Unemployment has also been rising steadily, to 5.9% as of December 2011. The outlook is compounded by Luxembourg's high reliance on the contracting financial services sector, which currently represents a massive 38% of the Grand Duchy's economy.

In conclusion, a policy mix has been put in place to address Luxembourg's structural challenges and budgets have been committed to support these measures. Assessments at the end of the current performance contract period of 2013 will provide good indicators of their effectiveness in the public sector. However, the full impact of the Eurozone crisis remains unknown and could certainly impact rates of private sector RDI. Luxembourg shares the demographic of an aging population and burdens of meeting pension and health care commitments in the longer-term. Thus

while the GDP forecast for 2013 is a more positive +2.3%, the economic outlook remains beyond the control of policy.

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1 Introduction

Luxembourg's characteristics as they relate to RDI are typically identified as its small size and the relative youth of its public research system. At the end of 2011 and in the midst of the Eurozone crisis, a third defining characteristic is the Grand Duchy's relatively strong economic position within the Eurozone 17, as well as the EU-27.

At 2,586 km^2, landlocked Luxembourg is the smallest EU member state except for Malta. It has a comparably small but growing population of 511,800, of which 43.2% are resident foreigners.[1] In addition to a resident workforce of 194,800, each day an additional 152,169 workers cross the borders of France (75,148), Germany (38,456) and Belgium (38,520) to work in the Grand Duchy. Unemployment is at 5.9% as of December 2011.[2]

In terms of the youth of its public research system, Luxembourg's first public research centres were established at the end of the 1980's, while a university was established by law as recently as 2003. These developments are reflected in Luxembourg's still evolving RDI absorptive capacity and in GERD's lagging both the Eurozone and the EU as a whole. GOVERD has been growing and, at 0.29%(p) of GDP in 2010, exceeded the EU-27 average of 0.27% but slightly lagged the Eurozone 17's 0.30.

Table 1: GERD and BERD as % of GDP

	2006		2007		2008		2009		2010	
	GERD	BERD	GERD	BERD	GERD	BERD	GERD	BERD	GERD	BERD
EU-27	1.85	1.17	1.85	1.18	1.92	1.21	2.01	1.24	2-00	1.23
Eurozone	1.87	1.19	1.88	1.20	1.96	1.24	2.06	1.27	2-06	1.27
Luxembourg	1.66	1.43	1.58	1.32	1.51	1.22	1.66	1.26	1.63	1.16(p)

Source: Eurostat, 24 Jan 2012 p=provisional

One notable trend is the decline in Luxembourg's BERD. While previously above the EU-27 and Eurozone average, it has been decreasing from 1.43% of GDP in 2006 to a provisional 1.16% in 2010, compared to the EU-27 average of 1.23%. Whether this reflects the impact of the financial crisis and decreased business research budgets or the transfer of research activities outside of the Grand Duchy is unknown, while continuing declines in GDP make assessing the causes difficult

Luxembourg's 2010 GDP per capita is an EU-leading €79,500, compared to the EU-27's €24,400 per capita ad the Eurozone 17's €27,600 per capita. In terms of GDP alone, however, the Eurozone crisis has shown an impact, as shown in Table 2.

[1] http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=384&IF_Language=fra&MainTheme=2&FldrName=1&RFPath=68

[2] http://www.statistiques.public.lu/fr/index.html

Table 2 : GDP Growth % Change

	2006	2007	2008	2009	2010	2011*	2012*	2013*
EU-27	3.4	3.1	0.5	-4.3	2.0	1.5	0.0	1.5
EU15	3.2	2.9	0.2	-4.3	2.0	1.4	0.5	1.4
Luxembourg	5.0	6.6	0.8	-5.3	2.7	1.1	0.7	2.3

Source: Eurostat, 24 Feb 2012 *Forecast

While the Eurozone crisis has caused GDP estimates to be revised downwards, with Luxembourg's 2011 GDP forecast going from 3.4% (11/2012) to 1.1% (02/2012). 2012 GDP is forecast at an anaemic 0.7% before recovering to a forecast 3.4% in 2013. Regardless, the government remains committed to increasing its investment in RDI, as shown in the table below. In the NRP Luxembourg 2020, the government set targets of between 1.5-1.9% of GDP for the private sector and 0.7-0.8% of GDP for the public sector for 2020. An intermediate target of 2.0% overall has been set for 2015.

Table 3: Government Public Sector R&D Investment Targets

Year	2008	2009	2010	2011	2012	2013	2014
Amount	€183.1m	€200.2m	€247.7m	€253.4m	€280.0m	€296.0m	€310.0m
% GDP	0.46	0.53	0.60	0.58*	0.60*	0.60*	0.59*

Source: Government of Luxembourg, 2011. *Estimate

Finally, to position Luxembourg as a member of the Eurozone in the midst of the current crisis, the Grand Duchy had the lowest deficit in GDP % terms in 2010 and remains one of the lowest in 2011. This suggests that current RDI budget commitments will continue to be met, as they were during the "Great Recession" of 2008-2009.

Table 4: Government Deficit and Debt Data as % GDP as of 21 October 2011

	EU-27 2009	Euro17 2009	Lux 2009	EU-27 2010	Euro17 2010	Lux 2010
Gov. deficit/surplus	-6.9	-6.4	-0.9	-6.6	.-6.2	-1.1
Gov. expenditure	51.0	51.1	43.0	50.6	50.9	42.5
Gov. revenue	44.1	44.7	42.1	44.1	44.6	41.4
Gov. debt	74.7	79.8	14.8	80.2	85.4	19.1

Source: Eurostat

One result of the size and youth of Luxembourg's public research system is that it targets specific research priorities. This is evidenced by the University's stated research focus areas and the CORE research programme, an outcome of a Foresight Study undertaken in 2006-2007. Priorities reflect not only societal challenges such as the CORE programme's "Identities, Diversity and Integration", but also private sector research interests such as "New Functional and Intelligent

Materials and Surfaces and New Sensing Applications." Another result is that Luxembourg is a model of researcher mobility--the majority of its researchers are foreign. Luxembourg's human resources in science and technology as a share of its total labour force, or HRST, is the highest in the EU-27—55.9% vs. an average of 40.5% in 2010—and 46.1%(p)[3] of 30-34 year olds have tertiary education compared to an EU-27 average of 33.6%, also in 2010. Note that figures for new PhD graduates through 2010 are not available.

The quality of Luxembourg's knowledge production is reflected in its scientific output. Figures on patent filings in the table below indicate that Luxembourg was one of the EU leaders in patent filings even before the new law on IP. (Note that figures for US Patent Office filings were the most recent available from Eurostat.) In terms of scientific publications, the web site Luxembourg Portal for Innovation and Research provides a full listing of publications by research organisation. The lists of peer-reviewed publications are extensive and also support the quality of Luxembourg's research.

Table 5: Patents filed per million inhabitants

EPO	2005	2006	2007	2008	2009
EU-27	114.8	115.76	114.81	115.52*	115.8*
Luxembourg	213.49	229.96	148.51	169.31*	154.79*
US Patent Office	**2002**	**2003**	**2004**	**2005**	**2006**
EU-27	49.95	40.37	32.27	40.04	24.74*
Luxembourg	73.96	61.63	83.46	114.37*	52.00*

Source: Eurostat *Provisional

The structure of Luxembourg's national research system (NRS) is straightforward and remained stable in 2011. At its head is the Superior Committee for Research and Innovation (Comité Supérieur de la Recherche et de l'Innovation), which has as its objective to ensure consistency and coherence in RDI policy. Established in 2008, its co-chairs are the Ministers of the Economy and Foreign Trade and of Higher Education and Research. The Ministry of Higher Education and Research (MESR) is in charge of the University of Luxembourg, the public research institutions Gabriel Lippmann, Henri Tudor, Santé,[4] and CEPS/INSTEAD, the digital library of the CVCE and the National Research Fund (NRF). Founded in 1999, the NRF oversees funding for public sector research programmes and administers the national funding programme for doctorate and post-doctorate studies, Aid for Research Training (AFR).

The Ministry of the Economy and Foreign Trade (MECE) manages private sector research programmes under the law of 5 June 2009 and contains Luxembourg's Office of Intellectual Property. Bridging the private and public sectors is national agency Luxinnovation. Established in 1984, Luxinnovation works with companies on identifying sources of funding and possibilities for public-private partnerships (PPPs),

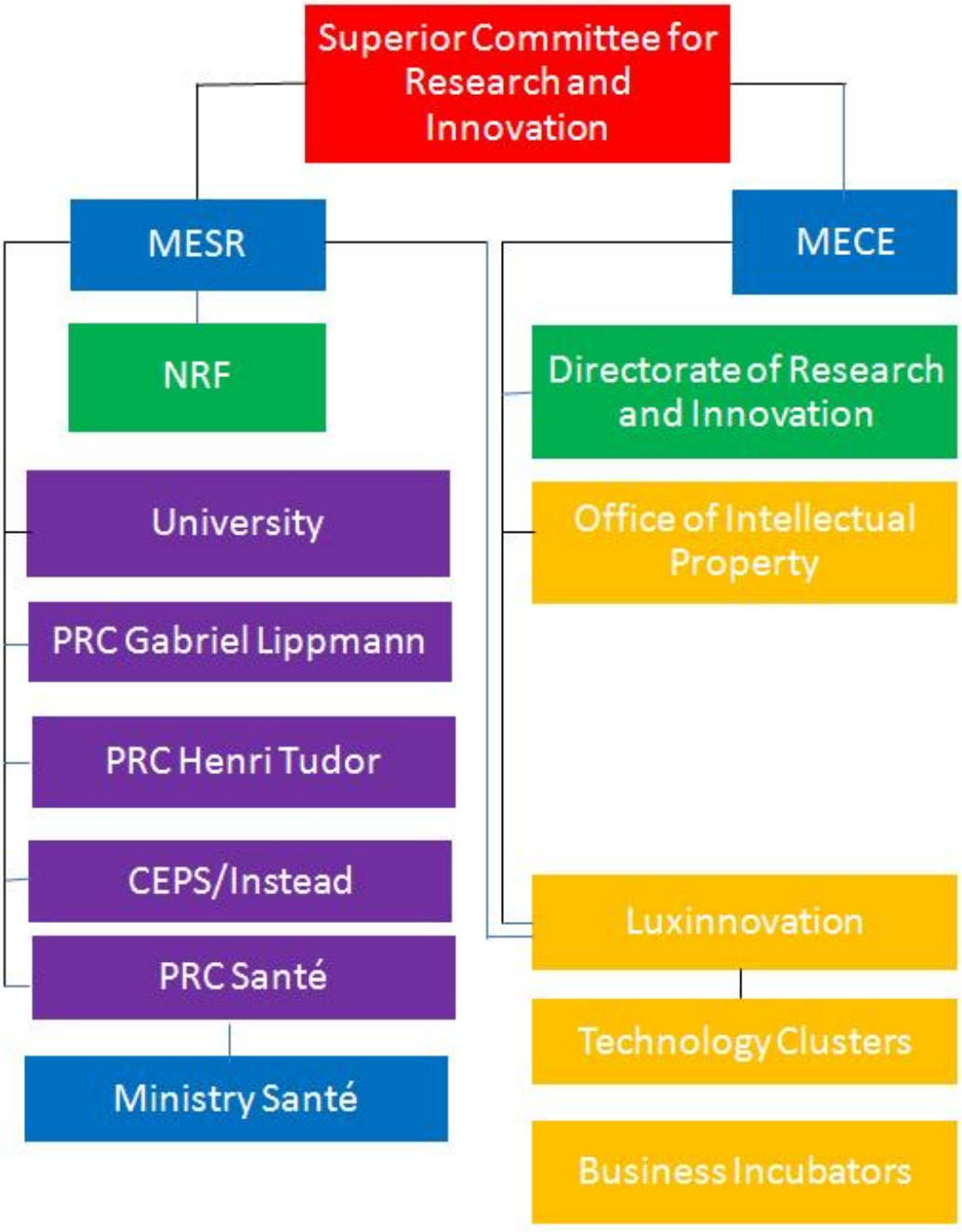
[3] (p) Provisional. Source: Eurostat, 7 Dec 2011.

[4] CRP Santé is also overseen by the Ministry of Health

organising sectorial clusters and assisting firms with EU and ESA project participation. Also for the private sector are business incubators such as the Technoport and funding opportunities such as innovation loans.

A diagram of Luxembourg's research and innovation system is included on the following page. The Superior Committee in red is a policy maker. The Ministries in blue are policy makers but funders as well. The green research funders are the NRF for the public sector and the MECE's Directorate for Research and Innovation, which is in charge of implementing the law of 5 June 2009 that provides state aid to private sector research. Public sector research performers are in purple, while yellow designates RDI support providers.

Figure 1: Luxemburg's research and innovation system



2 Structural challenges faced by the national system

In identifying structural challenges faced by Luxembourg's NRS, the *Innovation Union Scoreboard 2010* has been proposed as a significant resource. In the *Scoreboard*, Luxembourg ranked 10th, above the EU-27 average but still in the group of "Innovation Followers."[5] The Scoreboard also calculated that, within its group of Innovation Followers, Luxembourg 1) outperformed the EU in terms of its innovation growth performance, 2) was moderate compared to fast-growing Estonia and Slovenia, but 3) grew more quickly than Cyprus and the United Kingdom. The table below breaks out Luxembourg's results in terms of its Innovation Performance per Scoreboard Dimension.

Table 6: Innovation Union Scoreboard 2010, Luxembourg vs. EU-27

Dimension	Luxembourg ranking	EU-27 average ranking
Human resources	18	16
Open excellent attractive research systems	10	13
Finance and support	8	10
Firm investments	21	12
Linkages and entrepreneurship	12	15
Intellectual assets	7	8
Innovators	2	14
Economic effects	6	13

Source: Innovation Union Scoreboard 2010

The Grand Duchy's low score in *Firm Investments* indicated its relatively low 2009 BERD of 1.24%, compared to 1.94% in Austria and 1.32% in neighbouring Belgium, for example. Its rank in *Human Resources* reflected the low number of young PhD graduates, primarily due to Luxembourg's sole University being formed as recently as 2003. On the other hand, Luxembourg ranked high on the second indicator of the HR Dimension--its share of the population aged 30-34 with tertiary education was provisionally calculated to be 46.1% in 2010, vs. an EU-27 average of 33.6%.

Luxembourg's high score in *Innovators* confirms the results of a 2009 study by PRO CEPS/INSTEAD, which reported high levels of organisational innovation among companies in Luxembourg.[6] An earlier study,[7] which aimed to measure purely services sector innovation, ranked Luxembourg as number one among the EU-27, as shown in the chart below. The ranking is significant because of the high proportion of

[5] http://ec.europa.eu/research/innovation-union/pdf/iu-scoreboard-2010_en.pdf

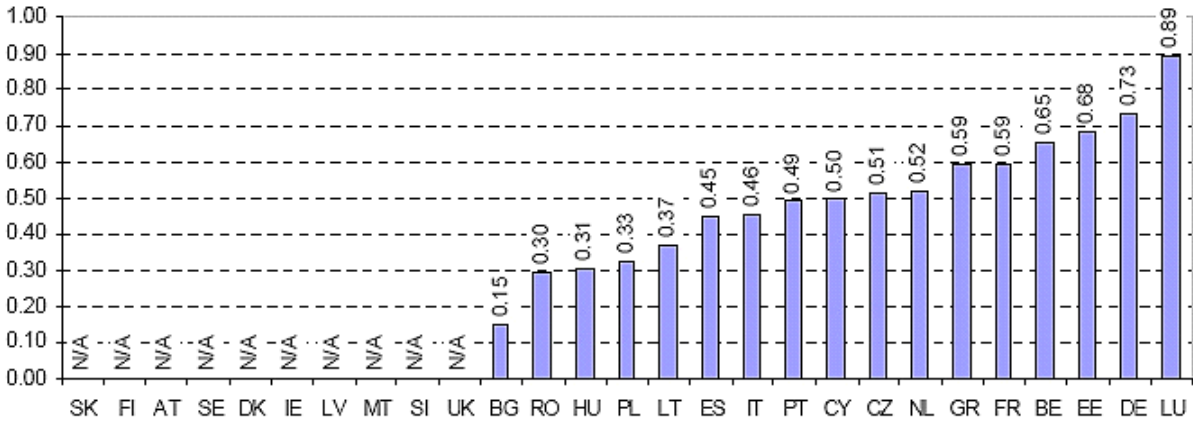
[6] http://www.eurofound.europa.eu/ewco/2009/09/LU0909019I.htm

[7] Kanerva, M. et al. (2006*). Can We Measure and Compare Innovation in Services?* TrendChart Innovation Policy in Europe, Innovation in Services Workshop.

GDP contributed by Luxembourg's services sector—86%--as well as services' creating 80.6% of the Grand Duchy's employment.[8]

The Kanerva study suggests that assessments of innovation performance, such as the *Scoreboard,* that include indicators such as *Medium- and high-tech product exports as a percent of total product exports* are not the most accurate way to evaluate Luxembourg's RDI landscape and identify its structural challenges, given the dominance of the services sector. Analysing other sources to ascertain the structural challenges faced by Luxembourg's NRS might be more useful.

Figure 2: Service Sector Innovation Index



Source: Kanerva et al. (2006)

Consequently, previous Country and Policy Mix Reports, the April 2011 Self-Assessment for DG RTD, the Innovation Union Competitiveness Report Country Profile for Luxembourg and other materials were also reviewed:[9] These resources suggest the following key structural—as opposed to policy--challenges for Luxembourg's RDI system.

Increasing absorptive capacity. At 1.63% in 2010, compared to an EU-27 average of 2.0%, Luxembourg's GERD remains comparatively low. The reasons traditionally given for this underperformance are the youth of Luxembourg's public research system and the consequent need to develop absorptive capacity. While time will take care of the first limitation, developing absorptive capacity is dependent not only on effective RDI policies, many of which are in place, but also on such factors as the economic environment and a successful diversification away from the dominant financial services sector.

The law of 5 June 2009 on State Aid for Research[10] is intended to encourage public-private partnerships, innovation in services and increased SME participation in research, including the secondment of public sector researchers. All of these provisions are expected to positively impact the development of greater RDI absorptive capacity, but the challenge remains.

[8] https://www.cia.gov/library/publications/the-world-factbook/geos/lu.html

[9] http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011/countries/luxembourg.pdf#view=fit&pagemode=none

[10] http://www.innovation.public.lu/catalogue-publications/financements/rdi-entreprise/aides-publiques-rdi-EN.pdf

Increasing Luxembourg's research profile through international cooperation. The NRF recognises the need for "international cooperation, particularly with a view to giving research in Luxembourg a higher profile in other countries and to achieving a critical mass within research that cannot be sought if the research context is limited to Luxembourg."[11] In addition, the same need is identified in the NRP for 2011, *Luxembourg 2020*, and is stated as "creating awareness of public R&D players to get them to participate more systematically in prospecting and economic promotion activities for Luxembourg abroad, in an effort to create closer links and more partnerships on joint projects."[12]

The Luxembourg Country Profile in the Innovation Union Competitiveness Report 2011[13] indicates that Luxembourg ranked 27th in terms of the number of FP7 applications and 26th in terms of the amount of EC contributions requested. Its success rate of 18.6% was below the EU-27 average of 21.6% and its financial contribution success rate of 11.3% was significantly lower than the EU-27 contribution success rate of 20.7%. While such results might be assessed as being a function of Luxembourg's size, as an EU leader in GERD per capita--€1,309.80(p) vs. an EU-27 average of €490.20 in 2010--as well as in areas such as researcher compensation[14], a better result is not an unreasonable expectation.

In addition, despite the Fit4Europe initiative that provides support to SMEs applying to European programmes,[15] SME applicants also had a lower success rate than the EU-27 average. These rates imply the existence of ongoing roadblocks to raising Luxembourg's international research profile.

The government, in *Luxembourg 2020*, agrees that "significant augmentation of participation in international programs and initiatives" is needed and sees this participation primarily in terms of FP7 and ESA programmes. Its goal is a financial return of €65 million from such projects in 2011-2013. In comparison, the period 2008-2010 returned €47.8 million.

Developing human resources in RDI. Luxembourg is a poster child for researcher mobility, open recruitment, equitable work contracts and fair compensation. Despite this, developing human resources in RDI remains a challenge. Like increasing absorptive capacity, addressing this challenge is partly a matter of time. A university was only created in 2003 and its programmes for PhDs are still evolving. The AFR programme, which funds PhD and post-doc work and is administered by the NRF, is currently supporting around 600 researchers. The ATTRACT and PEARL programmes "import" outstanding researchers and the NRF's "Promotion of Scientific Culture" activities aim to make a career as a researcher interesting to students.

Improving gender equality as a component of developing RDI resources is a greater challenge, the more so because it is not addressed by any specific policy measure.

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[11] http://www.fnr.lu/en/Research-Programmes/Research-Programmes/INTER-Programme

[12] http://ec.europa.eu/europe2020/pdf/nrp/nrp_luxembourg_en.pdf

[13] http://ec.europa.eu/research/innovation-union/index_en.cfm?section=competitiveness-report&year=2011

[14] See for example, http://www.eui.eu/ProgrammesAndFellowships/AcademicCareersObservatory/CareerComparisons/SalaryComparisons.aspx#Information

[15] http://www.innovation.public.lu/en/financer-projets/programmes-europeens/fit4europe/index.html

Luxembourg continues to rank either at the bottom or among the lowest in all measures of gender equality in the EU. Only 18% of researchers are female, compared to an EU-27 average of 30%. In the Humanities, the number drops to a mere 3, the lowest in the EU[16]. Women are also dramatically under-represented as the heads of institutions, on boards, at the higher levels of the ministries responsible for RDI policy and oversight and in executive positions where support for change would normally occur. The European Commission's She Figures report for 2009 states that the presence of women on boards "is absolutely essential to promote the cause of women in science; avoid a discriminatory snowball effect; and ensure better chances for diversity and excellence in research objectives and strategies."[17]

Developing a culture of evaluation among PROs. The Ministry of Higher Education and Research has instituted annual evaluations of PROs by a peer review process done by external international experts. Included in the process are departments of the public research institutions, as well as the University and the National Research Fund. While the evaluations announced in July 2011 resulted in many constructive recommendations; the reactions of some of the organisations indicated progress needs to be made in the acceptance and implementation of such input.[18]

Promoting a culture of entrepreneurship. Also identified as a challenge in the Self-Assessment done for DG RTD in April 2011, as well as previous ERAWATCH and TrendChart reports, a culture of entrepreneurship still needs additional development in Luxembourg. In the Innovation Union Scoreboard, Luxembourg has a rank of 12 in Entrepreneurship, lower than its overall rank of 10.

While the creation of spin-offs using IP from research activities are included in several PRO performance contracts, and there are business incubators such as the Technoport that offer expert support services to entrepreneurs,[19] "success stories" of start-ups that develop a reach outside the Grand Duchy are few and far between. A scarcity of venture capital remains an issue, despite initiatives like P&T Capital, launched in March 2011 by P&T Luxembourg to provide seed money to start ups in areas of ICT of interest to the P&T.

3 Assessment of the national innovation strategy

3.1 National research and innovation priorities

Luxembourg's national RDI strategy is founded on multi-annual planning and focuses on targeted priorities. It continues a process begun by an OECD review of Luxembourg's national research system undertaken in 2006[20] and a Foresight Study which was performed in 2006-2007 and which defined RDI priorities based on input

[16] See She Figures Report 2009, p. 44 http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf

[17] http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf

[18] http://www.mcesr.public.lu/recherche/rapports_evaluation/index.html

[19] http://www.technoport.lu/

[20] OECD Reviews of Innovation Policy: Luxembourg. http://www.oecd.org/document/6/0,3746,en_2649_34273_38629748_1_1_1_1,00.html

from a range of stakeholders. A major result of the OECD review was the recommendation to implement performance contracts between the MESR and the NRF, the University, the public research institutions and Luxinnovation. The second set of contracts was executed for the period of 2011-2013.[21] They must be considered integral policy documents and part of the Grand Duchy's RDI policy mix. One requirement of the performance contracts is an annual evaluation of an organisation or one of its departments. Results of the first mandated evaluations were published in July 2011, as well as the responses of the organisations to the evaluations.[22]

Luxembourg's current RDI priorities are specified in *Luxembourg 2020*, the National Reform Program under the Europe 2020 Strategy.[23] It reiterates Luxembourg's intention to continue to focus on a limited number of priority domains[24] and gives a special emphasis to initiatives in biohealth, eco-technologies and logistics.

The dominance of the services sector in Luxembourg's economy has also received a new emphasis in research policy. In addition to the CORE programme's thematic domain "Innovation in Services," PRC Henri Tudor established a department of "Service Science and Innovation," and the law of 5 June 2009 for private sector research support specifically covers innovation in services. Finally, the massive infrastructure project, Cité des sciences, must be considered to be an RDI priority. Funded with €565 million from 2008-2015, the Esch-Belval site will provide facilities for the University, PRCs Henri Tudor and Gabriel Lippmann and CEPS/INSTEAD, quarters for public-private partnerships and a business incubator. For 2007-2013, the FEDER Regional Competitiveness and Employment programme has allocated €15 million to co-finance the incubator and the building for the Luxembourg Centre for Systems Biomedicine (LCSB), which is part of the Grand Duchy's biohealth initiative.

3.2 Trends in R&D funding

Trends in Luxembourg R&D funding continue to be positive, despite the recent recession and the difficult economic environment anticipated in 2012. As stated in Section 1, the government has an intermediate target for GERD of 2.0% of GDP by 2015 and has targeted GERD between 1.5-1.9% of GDP for the private sector and 0.7-0.8% for the public sector by 2020.

Table 7 below provides main R&D funding indicators. While any indicator in euros is difficult to assess due to Luxembourg's small size,[25] indicators as a % of GDP show that Luxembourg's GERD has fluctuated at +/-1.60% for the three past years, which is lower than the EU average. However, the proportion of GERD contributed by the

[21] The University's runs from 2010-2013. http://wwwen.uni.lu/university/documents

[22] http://www.mcesr.public.lu/recherche/rapports_evaluation/index.html

[23] http://ec.europa.eu/europe2020/pdf/nrp/nrp_luxembourg_en.pdf. April 2011

[24] The priorities are: development and performance of financial systems; Higher quality and more productive business services; Information security and fiduciary management; High performance telecommunications networks; Sustainable management of water resources; Intelligent and functional materials and surfaces; Control of chronic, degenerative and infectious diseases; Challenges for the educational system, labour market, social protection, including the territorial aspects; Identities, diversity and integration

[25] With the exception of per capita indicators

Business Enterprise sector has fallen from more than 90% in 2000 to around 65.9%(p) in 2010, a shift that represents the government's commitment to developing the public research sector and implementing the Lisbon agenda, and not only lower levels of business R&D activity shown by BERD. The low showing from Higher Education Institutions is due to Luxembourg's having a single University, which was only established by law in 2003 and is still evolving

Table 7: Basic indicators for R&D investments in Luxemburg

	2008	2009	2010	2011	EU-27 average 2010
GDP growth rate	0.8	-5.3	2.7	1.1	2,0
GERD as % of GDP	1.57	1.66	1.63	-	2.0
GERD per capita	1,240	1,295	1,310	-	490.2
GBAORD (€ million)	176,554	195,447	233,541	-	92,729.05
GBAORD as % of GDP	0.43	0.46	0.58	0.6(p)	0.76
BERD (€ million)	482	471	466(p)	-	151,125.56
BERD as % of GDP	1.22	1.26	1.16(p)	-	1.23
GERD financed by abroad as % of total GERD	0.12	0.11	0.16	-	N/A[26]
R&D performed by HEIs (% of GERD)	0.0	-	0.1(p)	-	24.2
R&D performed by Private Non-Profit (% of GERD)	0.01	0.01	0.01	-	13.2
R&D performed by Business Enterprise sector (as % of GERD)	78.0*	70.3	65.9(p)	-	61.5

Source: Eurostat *2007 p = provisional

The main programme financing public sector research in Luxembourg's targeted priorities is the CORE programme. It had a budget of €73 million for the period 2008-2010 and has a budget of a further €69 million for 2011-2013. Interestingly, in the evaluation of the NRF undertaken by external experts at the request of the MESR,[27] an indication of the improvement in the scientific quality of the programme is the *decrease* in the number of successful proposals, which fell from 75% to 40%. This level is more similar to success rates in Germany and Norway. The fall in rates is also considered to reflect a more independent and transparent selection process.

Another significant trend in research funding is the requirement of the performance contracts that the PROs generate external revenues as a condition for receiving

[26] 8.4 (2009), 9.04 (2005)

[27] http://www.mcesr.public.lu/recherche/rapports_evaluation/Rapport_FNR.pdf

funding from the government. External funding is considered to come from contract work from the private sector and public-private partnerships, as well as from participation in programmes such as FP7, EUREKA, and ESA. Table 8 provides details for each organisation with a performance contract and indicates that, although the amount of government funding increases each year, so does the amount expected to come from external sources. PRC Henri Tudor has even launched a Department of Business Development, headed by two of its senior Directors, to address this requirement.

Table 8: Public and External Funding of PROs, in millions of euros

	2011	2012	2013	Total
PRC Henri Tudor				
Government	21.40	22.42	23.40	67.22
Contractual	8.93	9.91	11.00	29.84
Competitive	5.30	6.40	7.60	19.3
International	0.53	0.64	0.76	1.93
PRC Gabriel Lippmann				
Government	15.00	15.30	15.60	45.90
Contractual	3.70	3.80	3.90	8.40
Competitive	6.10	6.20	6.30	18.60
International	0.54	0.57	0.59	1.70
CEPS/INSTEAD				
Government	9.81	10.15	10.49	31.45
Contractual	2.94	3.31	3.65	9.90
Competitive	3.10	3.50	4.00	10.60
International	0.20	0.25	0.30	0.75
PRC Santé				
Government	20.10	21.50	23.00	64.60
Contractual	3.92	4-47	5.07	13.46
Competitive	8.64	9.56	10.60	28.80
International	0.69	0.86	1.06	2.61
CVCE				
Government	3.84	3.90	3.95	11.69
Third party	0.30	0.40	0.50	1.20
University				
Government	106.00	120.20	131.70	357.90
Third Party	18.00	20.00	23.00	61.00
National Research Fund	35.24	45.00	52.00	132.24
Luxinnovation	3.91	4.07	4.21	12.19

Source: Ministry of Higher Education and Research, 2011

For the private sector, the success of the law of 5 June 2009 was discussed above in Section 3.1. The programme Fit4Europe supports SMEs in developing proposals to participate in FP7 and ESA consortia and Luxinnovation's performance contract includes overseeing the Cluster Initiative, which aims to create economies of scale among sectors deemed to be technologically important for Luxembourg.

Although Luxembourg is too small to have specific regional funding, some of the funding for the Cité des sciences project came from FEDER.

3.3 *Evolution and analysis of the policy mixes*

Luxembourg has enjoyed a consistent and coherent RDI policy mix for the past decade, in large part because of the stability of its government and its commitment to the Lisbon agenda. The Prime Minister, Jean Claude Juncker, is the world's longest serving democratically elected leader (in office since 1995), while the Ministers of the Economy and Foreign Trade and of Higher Education and Research have held their positions since 2004. This has produced reliable, long-term policies and dependability in their implementation. There have been no instances of "new brooms sweeping clean." While the Minister of the Economy and Foreign Trade is stepping down as of 1 February 2012, his successor is a member of the same party and currently head of the Ministry's DG Economic Development, Industry and Business, which should ensure policy continuity.

In the ERAWATCH Research Inventory, written at the end of 2010 and early 2011, major components of an RDI policy mix were designated as:

- Fiscal policies
- Human resource policies
- Interaction between Knowledge Triangle policies.

While not exhaustive, these categories provide a basis for analysing Luxembourg's RDI policy mix.

Fiscal policies. Fiscally, Luxembourg's law of 5 June 2009, which provides state aid for private sector RDI, with a special focus on SMEs and services sector innovation, is a successful replacement of the former law, which tended to focus on RDI in the industrial sector. As the services sector contributes 86% of the Grand Duchy's GDP, the shift to service sector innovation is a positive development.[28]

A second law of 18 February 2010 covers eco-innovation, one of Luxembourg's targeted RDI priorities. The law outlines six forms of investment that may be eligible for public aid: investments enabling companies to exceed Community standards or to increase the level of environmental protection in the absence of such standards; early adaptation by SMEs to future Community standards; investments in energy saving; investments in high-efficiency cogeneration; investments in the production of energy from renewable energy sources; environmental studies.

A law on IP tax incentives, the law of 21 December 2007, allows 80% of net income from the exploitation of IP registered in Luxembourg to be exempt from tax. Thus while company income is currently taxed at 29.63%, the rate of taxation for IP-

[28] https://www.cia.gov/library/publications/the-world-factbook/geos/lu.html

derived income is 5.93%. This encourages companies to patent and license the results of R&D work, as well as fosters spin offs and start-ups based on IP.

Finally, Luxembourg is regarded as having a generally positive business environment, which persuaded online retailer Amazon to establish its European headquarters in the Grand Duchy and create 400 new jobs. In December 2011, US Netflix announced it would also open its European headquarters in Luxembourg, which further attests to the Grand Duchy's attractive fiscal environment and supportive policies.[29]

Human resource policies. Luxembourg is a model for researcher mobility, as most of the researchers working in Luxembourg are foreign. Lacking a University until 2003, Luxembourg has instituted a range of policies and funding programmes to both attract outside researchers to the Grand Duchy and develop native talent.

The NRF has two programmes to bring external researchers to work in Luxembourg. The ATTRACT programme is targeted at outstanding younger researchers from abroad two-to-eight years beyond their doctorates. Candidates submit research proposals with a host PRO. Funding is up to €1.5m for up to five years for the researcher and research team. Host institutions offer a candidate the prospect of building up and integrating their project into the PRO's activities. The PEARL programme offers PROs the means to recruit senior researchers in areas of strategic importance to Luxembourg. Funding of €3-5m is available for the best candidates with one or two awards made per year.

Luxembourg is a member of the Euraxess initiative and has its own Euraxess web site. The Luxembourg Portal for Innovation and Research has links to researcher job openings and internships and all PROs also list openings for researchers, including PhD and post-doc positions. The University of Luxembourg has joined the NRF and PRC Santé in signing the European Charter for Researchers.

The major programme for developing new researchers is the Aid for Research Training (AFR) grant programme which supports researchers in doctoral and post-doctoral work. Research may be done in Luxembourg or abroad and recipients may be Luxembourg nationals or foreigners, including non-residents. Since October 2008, €54 million has been committed to fund the work of 670 PhD and post-doc researchers. The programme ensures recipients enjoy work contracts with the host institution that include social benefits.

The NRF is also responsible for the Promotion of Scientific Culture which has included a Researchers Night in Luxembourg City in September 2011. In addition, the NRF has created a Facebook page, Mister Science, as well as a website, Cherchons Chercheurs, targeted at ages 12-20 with quizzes and contests as well as information about becoming a researcher. The purpose of such activities is to make research an attractive career choice.

In raising gender equality as a human resources issue, it should be noted that Luxembourg ranks at the bottom or among the lowest in the EU for gender equality in RDI and that there are no policies in place to address this issue.

[29] http://www.forbes.com/sites/timworstall/2011/12/07/netflix-opens-in-luxembourg-yes-tax-rates-matter/

Interaction between Knowledge Triangle policies. There are two main knowledge triangle initiatives currently being undertaken. The first is the Cité des sciences infrastructure project that will bring together all three knowledge triangle actors and is described in Section 3.1 above.

The second is the decision to develop Luxembourg as a biohealth centre. This has also involved all knowledge triangle members as stakeholders, from the University to the PROs to start ups. Membership of the Biohealth Cluster is indicative of the inclusiveness of the initiative.

On a more general policy level, performance contracts that mandate PRO revenues from contractual work that includes public-private partnerships as well as spin offs and start-ups that leverage IP produced by the PROs also emphasise knowledge triangle relationships. Finally, the law of 5 June 2009 supports the secondment of researchers from the public sector to private enterprise.

3.4 Assessment of the policy mix

Overall, Luxembourg has a well-defined and precisely targeted mix of RDI policies. It is a benefit that most are multi-annual, since the majority, if not all, of the Grand Duchy's challenges need time as well as policy measures to resolve, Many RDI policies and programmes are outcomes of the OECD review and the Foresight Study. In particular, the PRO performance contracts are an implementation of an OECD recommendation and a second set for the period 2011-2013 have followed the initial group for 2008-2010.[30] The performance contracts are considered to be fundamental components of Luxembourg's RDI policy mix. The NRF CORE programme is a direct result of the Foresight Study.

On the whole, policy mix implementation has been efficient and appropriate. On the public sector side, an example is the NRF proposal acceptance rate discussed above, which indicates significant improvements in the scientific quality of the research projects funded as well as greater transparency and independence in the proposal review process As increased income from competitive funding is a performance contract requirement, as per Table 8 above, the new policies are also compelling improvements in the scientific quality of the work of the PROs.

On the private sector side, the expanded Cluster Initiative and advancements on the biohealth initiative exemplify progress. Enterprises have also been quick to take advantage of new policies, such as the law of 5 June 2009 and the support of PPPs. The success of the new law is reflected in the fact that, instead of the 80 projects anticipated to receive aid in 2008-2010, 143 projects were supported. During 2011-2013, 240 projects are expected to take advantage of the law, which has a budget of €46 million in 2011, rising to €65 million in 2013.

Table 9 below provides a summary assessment of how the policy mix addresses the structural challenges identified in Section 2. In terms of increasing absorptive capacity, Luxembourg's targets for BERD and the law of 5 June 2009 that provides support for private sector research address this challenge. While currently government budget commitments remain secure, what is beyond the control of these policies is the economic environment and its impact on private sector RDI.

[30] Note the University's contract covers 2010-2013, which is the same period as its Quadriannual Plan. See http://wwwen.uni.lu/university/documents

Appropriate policies are in place to increase Luxembourg's international research profile and the government has recognised this issue in the *Luxembourg 2020* NRP. Funding from international project participation is expected in PRO performance contracts. The issue of the administrative burden of private sector participation is also recognised in *Luxembourg 2020* and a solution is being sought beyond the Fit4Europe initiative, which assists in the costs of proposal preparation but not the overheads associated with actual project participation.

The PEARL and ATTRACT programmes bring first-rate research talent to Luxembourg, while the AFR PhD and post doc funding programme is highly effective in developing future researchers. The NRF also is active in promoting research as a career. However, given Luxembourg's bottom-of-the-heap ratings on gender equality among researchers, it is an issue that there are no specific policies in place to improve the situation.

The public announcement of the results of the evaluations of the PROs by the Minister of Higher Education and Research and the publishing of the evaluations and the responses of the PROs on the MESR web site is an excellent example of the transparency recommended in the OECD review. The reactions to the evaluations by some of the PROs were less encouraging and it is not obvious what the follow up will be in terms of tracking the implementation of some of the recommendations.

There are policies in place to encourage entrepreneurship, from the law giving preferential tax treatment to revenues from IP to the availability of first-rate business incubators. However, all assessments agree that it remains a challenge to be an entrepreneur in the Grand Duchy. Significant influences are societal attitudes towards risk and the perception that a career as a civil servant or a banker is preferable. Costs and difficulties associated with launching a start-up also need improvement.

Table 9: Policy Mix Assessment

Challenges	Policy measures/actions[31]	Assessment in terms of appropriateness, efficiency and effectiveness
Increasing absorptive capacity	Luxembourg 2020 BERD targets: targeting new fields as RDI priorities; law of 5 June 2009.	Policy mix is appropriate and efficient; private sector measures are vulnerable to economic environment which is unavoidable but still impacts effect. A concern is current decrease in BERD.
Increasing research profile through international cooperation	INTER programme and NRF cooperation agreements; Fit4Europe programme; performance contract requirement for PRO revenue from international projects; issue in Luxembourg 2020 NRP	Appropriate policies are in place; the question of their effectiveness remains. It is possibly a "learning curve" issue and more time is needed to see results. The administrative burden of EU project participation should not be under-estimated, especially for SMEs.
Developing human resources in RDI and	AFR programme for PhDs and post-docs; ATTRACT and PEARL programmes, Charter for	Appropriate policy mix is in place for HR development; time is needed to see results. There are no specific policies to promote the issue of

[31] Changes in the legislation and other initiatives not necessarily related with funding are also included.

improving gender equality	Researchers acceptance, NRF Promotion of Scientific Culture activities	gender equality, on which Luxembourg places low in EU rankings.
Developing a culture of evaluation	Mandated annual evaluations	The MESR's publishing the evaluations and the PROs responses was a model of transparency. However, ithe process for following up on the implementation of recommendations is not obvious.
Promoting a culture of entrepreneurship	IP/spin-off requirements in performance contracts; Master in Entrepreneurship and Innovation; business incubators; IP law; law of 5 June 2009	While supportive policies are in place, it remains difficult and time consuming to get a business license, while start-up costs are expensive and venture capital is scarce. Social change in attitudes towards entrepreneurship is also needed.

4 National policy and the European perspective

Because of its small size, Luxembourg has always tended to look beyond its national borders and has been an active supporter and participant in the "European project" from its beginning. Throughout 2011, Prime Minister Jean Claude Juncker has also been the President of the "Euro Group" and working in support of the currency and to find solutions to the Eurozone crisis.

Support of European Union goals and agendas has also resulted in embracing ERA objectives. A young public research system has meant a lack of entrenchment or fossilisation and gaps in the policy mix have been filled with measures representing "best practice" as well as supporting ERA aims.

Short-term, a main focus of Luxembourg's policy mix will be how well PROs fulfil their 2011-2013 performance contract requirements. Many of these requirements also align with ERA pillars and objectives that include increasing cross-border and international cooperation, promoting knowledge circulation across Europe and undertaking public-private partnerships. Performance contracts as a whole support the development of excellence in research institutions and ongoing evaluations of the PROs also foster improvement.

The biohealth initiative has already resulted in new research infrastructures and further progress on the Cité des sciences project will provide Luxembourg with a truly world-class research hub for all knowledge triangle actors. Continuing to support and expand the AFR programme for PhDs and post-docs that include work contracts and social benefits improves the labour market for researchers both in Luxembourg and the ERA.

Medium-term, projects and researchers funded by the PEARL and ATTRACT programmes will be completed and the results assessed. Research priorities in biohealth, eco-technologies and logistics will also have developed to the point that undertakings can be assessed and adjustments to provisions made if required. All of these involve components of cross-border and international cooperation and public-private partnerships, while PEARL and ATTRACT directly address the dimension of the researcher labour market. The AFR programme will have produced enough PhDs so that its impact on the labour market for researchers can also be gauged. In

addition, a new set of performance contracts beginning in 2014 will be implemented, with their terms reflecting the results of the 2011-2013 contracts.

Table 10 below provides a summary of main national challenges in terms of the ERA objectives and indicates policies which address both the dimension and the challenge. Luxembourg's RDI policy alignment with ERA objectives is detailed in the Annex. An indication of their congruence is evident in the *Luxembourg 2020* NRP, which also specifically targets the development of research infrastructures via the Cité des sciences, the support of public-private partnerships through the law of 5 June 2009, the promotion of cross-border cooperation and knowledge circulation across Europe by setting targets for participation in European consortia, and the development of excellence in research institutions, the strengthening of international cooperation and the promotion of public-private partnerships by specifying biohealth, eco-technologies and logistics as RDI priorities.

Table 10: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA dimension	Main challenges at national level	Recent policy changes
1	Labour Market for Researchers	Developing native researchers; promoting more equal gender representation	Inclusion of work contracts in AFR programme; no specific policies promoting more equal gender representation
2	Cross-border cooperation	Increasing international profile	PRO performance contracts; NRF programmes and measures; Luxembourg 2020 NRP targets
3	World class research infrastructures	Completing Cité des sciences project	Major RDI goal in Luxembourg 2020 NRP
4	Research institutions	Developing commercial mind-set to meet performance contract external revenue requirements; developing entrepreneurial spirit to meet IP and spin-off requirements; developing a culture of evaluation	Performance contracts requiring external revenues through contract work and PPPs as well as commercialisation of research results; requirements for evaluations
5	Public-private partnerships	Increasing absorptive capacity	Included in revenue targets in PRO contracts: supported in law of 5 June 2009 for private sector research
6	Knowledge circulation across Europe	Increasing international profile	NRF Inter programme, international cooperation agreements and Accompanying Measures

	ERA dimension	Main challenges at national level	Recent policy changes
7	International Cooperation	Increasing international profile	PRO performance contracts; NRF programmes and measures; Luxembourg 2020 NRP targets

Annex: Alignment of national policies with ERA pillars / objectives

1. Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers

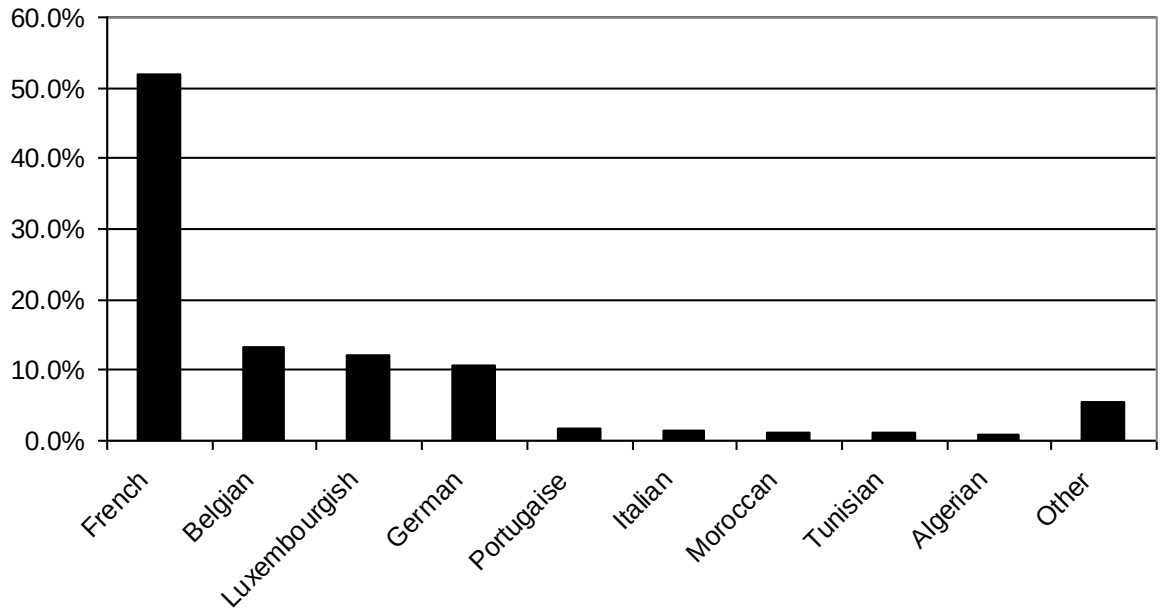
In general, Luxembourg provides an open, attractive labour market for researchers and has policies in place to develop its own native researcher resources.

1.1 Supply of human resources for research

With 55.4% of its economically active population in science and technology (HRST), compared to an EU-27 average of 40.5% (2010), Luxembourg is well provided with human resources. As 46.1% (provisional) of its population of 30-34 year olds have tertiary education, Luxembourg also exceeds the EU-27 average of 33.6% in 2010 as well as the target rate of 40%. Another Eurostat measurement suggests that 1.22% of the Grand Duchy's work force were designated as researchers in 2007, the only year for which a figure is available. The EU-27 average for that year was 0.99%.

There are no statistics available on PhD graduates from Eurostat; however, the AFR programme for funding doctoral and post doc studies has made 511 PhD grants and 159 post doc grants since October 2008. In addition, there are no figures on inward and outward flows of researchers. However, in the chart below which shows the proportions of nationalities working at PRC Henri Tudor in 2009; only 12% are Luxembourgers and the rest are from abroad. This means Luxembourg is highly dependent on its foreign researchers and what is a brain gain for Luxembourg could also become a brain drain. More native researchers are needed to offset such an excessive dependency. It is also the case that some local perspective is useful in addressing certain of Luxembourg's societal challenges such as education and diversity and social integration.

Figure 3: Nationalities working at PRC Henri Tudor, 2009



1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed

Luxembourg is known for its high quality of life. The study by CARSA undertaken for the EU on researchers compensation found Grand Duchy researchers had the second highest average weighted total yearly salary, surpassed only by Switzerland and the highest among EU nations (EC Enterprise DG, 2007).

CEPS/INSTEAD and the University of Luxembourg have joined the NRF and PRC Santé in signing the European Charter for Researchers, which specifies the roles, responsibilities and entitlements of researchers as well as employers and/or funders of researchers. In terms of social benefits, all researchers and their families are enrolled in the social security system. Parental leave, both maternal and paternal, is supported. Full details are available on Luxembourg's EURAXESS site.

In addition, the NRF has a range of accompanying measures for researchers which support ongoing training, conference attendance, the costs of publishing research, including PhD theses, and cross-border mobility.

1.3 Improve young people's scientific education and increase interest in research careers

Luxembourg's NRF has been charged with the Promotion of Scientific Culture, a mission that includes increasing interest in research as a career. The NRF has created a Facebook page, Mister Science, as well as a website, Cherchons Chercheurs, targeted at ages 12-20 with quizzes and contests as well as information about becoming a researcher. In addition, the NRF organises a Researchers Night in Luxembourg City where researchers present their work in venues throughout the capital, as well as has PhD candidates present their work in secondary schools.

1.4 Promote equal treatment for women and men in research

Luxembourg continues to do poorly in terms of equal treatment for men and women, according to the She Figures report of 2009, published by the European Commission.[32] With an EU-27 average of women researchers at 30%, Luxembourg shared a bottom rating with the Netherlands at 18%. In Humanities, Luxembourg ranks lowest, with *only 3% of researchers being women*. Luxembourg ranks next to lowest for women in Grade A academic careers and among the highest in its Glass Ceiling Index (GCI) which indicates the difficulty of a woman being promoted to a higher position. A rating of 1 indicates there are no differences between men and woman being promoted. Luxembourg's GCI is near 11.

Luxembourg also ranks at the bottom for female heads of higher education institutions. This is significant because it is these institutions that award PhD degrees to future researchers. Luxembourg also ranked lowest in the relationship between the level of R&D spending per capita and the proportion of women in R&D. The She Figures study found a highly negative relationship between the level of spending on R&D per capita and the proportion of women in R&D. Luxembourg's GERD per capita was €1,309.80 in 2010 and the highest in the EU, compared to an EU-27 average of €490.20 of GERD per capita that year.

[32] http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf

Finally, Luxembourg ranks last for female representation on boards, which is also indicated in the table below that reflects the situation two years later than the European report. The She Figures report states:

"In policy terms, it is crucial to promote a high representation of women on boards that determine scientific policy. Their presence is absolutely essential to promote the cause of women in science; avoid a discriminatory snowball effect; and ensure better chances for diversity and excellence in research objectives and strategies."

Given these results, it is all the more striking that there are no policies at all to foster more equal treatment for women in research. It should be noted the female representation at higher levels in the private sector in Luxembourg is no better and a recent initiative to mandate a minimum proportion of women on corporate boards, as is the case in Sweden and France, was also stillborn.

Table 11: Female Representation on Boards in Luxembourg, November 2011

Actor	Group	Male	Female	% female
Superior Comm. for Research and Innovation	Members	10	1	9
PRC Henri Tudor	Board	11	0	0
PRC Henri Tudor	Management Board	8	2	20
NRF	Administrative Board	10	2	16.7
Uni	Board	6	1	14
Uni	Rectorate	4	1	20
PRC Lippmann[4]	Board	9	1	10
CEPS/INSTEAD	Administrative Board	6	3	33
CEPS/INSTEAD	Scientific Council	15	1	6.7
CRP Santé	Management Board	2	1	33
CRP Santé	Administrative Board	12	0	0
CRP Santé	Scientific Advisory Board	12	0	0

2. *Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding*[33]

Luxembourg's research programmes, such as the NRF's CORE programme, are open to foreign institutional participation. However, funding is only given to the national participant. The PEARL and ATTRACT programmes are designed to bring external researchers to Luxembourg and fund projects done in conjunction with one of Luxembourg's PROs or the University. Note that foreign researchers working at a Luxembourg research institution are regarded as Luxembourg researchers, even if they do not reside in the Grand Duchy, and that the majority of researchers in Luxembourg are foreign.

The NRF supports cross-border cooperation. An example is the US National Science Foundation (NSF) programme, "Catalysing New International Collaborations . The NSF supports the participation of U.S. researchers and students in activities intended to catalyse new international collaborations. To stimulate the cooperation between US and Luxembourg scientists, the FNR provides matching funds for the Luxembourg partners on successful NSF proposals. The INTER programme, which runs from 2006-2014 and has a budget of €12 million for 2011-2013, is the measure generally used to support Luxembourg researcher participation in international projects.

To support its role in fostering cross-border cooperation, the NRF participates in European Heads of Research Councils (EUROHOCS), the European Science Foundation (ESF) and the International Council for Science (ICSU).

For the private sector, Luxinnovation runs the programme Fit4Europe, which provides Luxembourg companies preparing a proposal for a European research project such as FP7, Ambient Assisted Living or Eurostars, with financial support from the Ministry of the Economy and Foreign Trade. A lump sum, depending on whether the company is participating as a project participant or project coordinator, covers internal expenses associated with partner searches and proposal preparation as well as external expenses associated with experts and consultants.

3. Develop world-class research infrastructures (including e-infrastructures) and ensure access to them

The ESFRI web site indicates Luxembourg's Road Map remains under preparation and there are no recent policy developments in terms of Luxembourg's accessing intergovernmental European infrastructures.

In terms of Luxembourg's own research infrastructures, the massive Cité des sciences project, with a budget of €565 million over 2008-2015, will provide facilities for the University and three of the public research organisations, as well as work

[33] Promote more critical mass and more strategic, focussed, efficient and effective European research via improved cooperation and coordination between public research funding authorities across Europe, including joint programming, jointly funded activities and common foresight.

- Ensure the development of research systems and programmes across the Union in a more simple and coherent manner.
- Promote increased European-wide competition and access of cross-border projects to national projects funding

spaces and laboratories for public-private partnership projects and a business incubator. Business incubator facilities are anticipated to open in 2012.

Luxembourg's Biohealth initiative, and its Personalised Medicine Consortium, can also be considered as a research infrastructure. The Integrated Biobank of Luxembourg (IBBL) recently occupied a purpose-built structure in the same area as PRC Santé and the Luxembourg Hospital Centre, while the Luxembourg Centre for Systems Biomedicine (LCSB) is quartered in a new, purpose-built structure in Esch Belval that is part of the Cité des Sciences. All members of the Personalised Medicine Consortium work with international partners.

In terms of e-infrastructure, the resources of the CVCE are freely available to all visitors online. The NRF has also launched an effective online submission system for project proposals and AFR grants, the latter of which are also open to any PhD candidate or post doc. The Luxembourg Portal for Innovation and Research provides an inclusive resource on RDI in the Grand Duchy and includes a Partner Finder function. Private sector research actors can provide profiles as potential research partners.

4. Strengthen research institutions, including notably universities

Luxembourg's sole University was founded by law as recently as 2003, which could be regarded as Luxembourg's most significant act of strengthening research institutions, given the public research system was only created in the late 1980's. From the beginning, the University was envisioned to be a research, and not simply a teaching, university. It has targeted specific research focus areas on which it concentrates and which consequently impact the research which is supported. Hiring is autonomous Otherwise the University functions under the terms of its Multiannual Contract 2010-2013 with the MESR and the law of 12 August 2003 under which the University was founded.

Evaluations of both the University and other PROs are mandated; developing a culture of evaluation has been identified as one of Luxembourg's structural challenges. The University, for its part, has been receptive to evaluation and also undertakes self assessment reporting which it publishes on its website. Funding, including block research funding, is governed by the terms of the contract between the University and the government for 2010-2013, which mandates the following:

- Publications in journals or proceedings: 2 per year for each teacher-researcher (full time equivalent)
- Citations, excluding self-citations: 6 per year for each teacher-researcher (full time equivalent)
- Number of theses submitted: 190
- Number of patents: 6
- Number of licenses: 2
- Number of funded chairs: 6

5. Facilitate partnerships and productive interactions between research institutions and the private sector

Since the OECD review of Luxembourg's RDI system, an increasing emphasis has been placed on public-private partnerships. Although these have existed since the

PROs were formed, now revenues from "contract" work form part of the performance contracts of PRCs Henri Tudor, Gabriel Lippmann, Santé, and CEPS/INSTEAD, while the University is expected to generate revenues from "third party" research. In addition, private sector companies provided input to the NRF Foresight Study and four of the five thematic domains reflect private sector research interests as well as the specialties of the PROs. [34] The Boards of all PROs, as well as the University, have members from the private sector.

In addition to public-private partnerships, knowledge transfer is facilitated by conferences and training. The Luxembourg Portal for Innovation and Research has a complete listing of conferences and other RDI-related events. In terms of knowledge transfer via training, PRC Henri Tudor has an entire department, SiTEC, dedicated to offering training, while PRC Gabriel Lippmann hosts the Nanobeams PhD School.

The law of 5 June 2009, in support of private sector innovation, allows for the secondment of public sector researchers to companies.

In addition, a Cluster initiative, managed by Luxinnovation, is organised into groups focusing on ICT, Biohealth, Ecoinnovation, Materials and Space. The initiative was launched in 2002 and actively encourages networking between the private and public sectors. Its emphasis is placed on key technologies that have been identified as being important for the future sustainable development of the Luxembourg economy.

Luxinnovation also organises Business Meets Research days, at which public research institutions present their capabilities to private sector companies. The Luxembourg Portal for Innovation and Research has a section devoted to public research and a function, "Finding Partners."

6. Enhance knowledge circulation across Europe and beyond

The NRF actively encourages collaboration between researchers in Luxembourg and abroad and has instituted cooperation agreements[35] with a range of international research agencies and initiatives. It is a member of eight ERA-NETS. The INTER programme provides funding for Luxembourg participation in international projects, while the CORE programme welcomes international partners although project funding is limited to the Luxembourg participant. Luxembourg is also a full member of the European Space Agency.

To encourage knowledge circulation *into* Luxembourg, the NRF has launched two programmes, ATTRACT and PEARL, to bring researchers from outside the Grand Duchy to a PRO to assemble a research team and undertake a project, usually in one of the CORE thematic domains.

In terms of access to both research outputs and inputs, CEPS/INSTEAD makes its data available to international researchers, while the CVCE is an online resource available to all. Publications from all PROs are listed on the Luxembourg Portal for Innovation and Research and a calendar of conferences is also listed.

[34] The fifth thematic domain is Societal Challenges.

[35] Luxembourg participates in projects funded through INTER programme support with SNFN, Switzerland (lead agency agreement), CNRS, France (bilateral agreement), BELSPO, Belgium (three joint programmes), DFG, Germany (cooperation agreement) and FWO, Flanders (cooperation agreement). It also participates in the ESF's EUROCORES programmes and has agreements with the US NSF.

7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world

Luxembourg's strategy for international cooperation is best stated by the NRF, "The NRF actively encourages research collaboration between researchers in Luxembourg and abroad. Indeed, Luxembourg does not possess a critical mass of researchers that would allow the creation of high-performance research teams in all scientific domains and, in order to achieve international excellence, it is paramount for researchers cross national borders [sic]. In order to optimise the visibility of Luxembourg as an attractive site for research activities within Europe, the NRF plans to reinforce collaborations with selected countries as well as its own international cooperation instruments."

International cooperation is covered by the agreements entered into by the NRF with other countries which provide frameworks for both bi-lateral and multi-lateral project funding. An example of the latter is the NRF's participation in the EUROCORES scheme of the European Science Foundation (ESF). Complete details of cooperation agreements and calls can be found on the NRF website.

The INTER programme for "the promotion of international cooperation", administered by the NRF, runs from 2006-2014 and has funding of €12 million for 2011-2013. Its purpose is to fund the participation of public sector researchers in international projects. 35 projects have been funded since the programme's inception and €9 million have been allocated. In addition, the NRF has an Accompanying Measure that supports researcher participation in conferences abroad. Another Accompanying Measure, Mobility of Researchers, funds researcher participation in projects abroad from one month to one year, with up to €3,000 per month for expenses. The same measure can be used to bring foreign researchers to Luxembourg.

Because of its size and limited absorptive capacity, Luxembourg's international partnerships also tend to reflect its targeted research priorities. The ERA-NETS of which it is a member align with research foci. MATERA: Material Sciences and Technology and MNT: Micro- and Nanotechnology complement the CORE thematic domain "New Functional and Intelligent Materials and Surfaces" and departments in PRCs Gabriel Lippmann and Henri Tudor and the University's Research Unit, Physics and Materials.

Luxembourg's Biohealth initiative also relies on international cooperation. The Personalized Medicine Consortium, which includes recently formed Luxembourg institutions like the Integrated Biobank of Luxembourg (IBBL), the University's Luxembourg Centre for Systems Biomedicine (LCSM) and the Programme for Personalised Medicine (PPM) within PRC Santé, partners with scientists in the US and Japan as well as Europe. The initiative will specifically undertake research on cancer, Type 2 diabetes and Parkinson's disease, which are associated with an aging population and a major societal challenge. Also addressing the challenge of an aging population is NRF's participation in the Ambient Assisted Living programme and ERA-AGE 2: Aging.

References

Alexander, S. (2010): ERAWATCH Country Reports 2010: Luxemburg

Alexander, S. (2009): ERAWATCH Country Report 2009, Analysis of policy mixes to foster R&D investment and to contribute to the ERA: Luxembourg, JRC Scientific and Technical Reports.

Cammarata, L. (2010): ERAWATCH Research Inventory Report for Luxembourg, European Commission.

Cammarata, L. (2009): INNO-Policy TrendChart, Innovation Policy Progress Report: Luxembourg, European Commission.

European Commission, Directorate General Enterprise (2007): Remuneration of Researchers in the Public and Private sectors. Retrieved March 11, 2009. http://www.cipur.it/Varie/Forum%20DDL112/Study%20remuneration%20researchers.pdf

European Commission Directorate General Research (2009): She Figures, Statistics and Indicators on Gender Equality in Science, Retrieved October 22, 2010 from http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf

European Cooperation in Science and Technology – COST (2009): Annual Report 2009, Brussels.

Fonds National de la Recherche Luxembourg – NRF (2007): FNR Foresight: Thinking for the Future Today, Luxembourg.

Fonds National de la Recherche Luxembourg – NRF (2010): Annual Report 2010, Luxembourg. Retrieved November 30, 2010 from http://www.fnr.lu/en/Publications/Annual-Reports

Government of Luxembourg (2011): Luxembourg 2020: National Reform Program of the Grand-Duchy of Luxembourg under the Europe 2020 Strategy, Retrieved October 22, 2011, http://ec.europa.eu/europe2020/pdf/nrp/nrp_luxembourg_en.pdf

Kanerva, M. et al. (2006): Can We Measure and Compare Innovation in Services? TrendChart Innovation Policy in Europe, Innovation in Services Workshop

Luxinnovation (2011): 2010 Rapport Annuel, Luxembourg.

OECD (2007): OECD Reviews of Innovation Policy: Luxembourg, Paris, OECD.

Statec (2011): Le Portail des Statistiques du Luxembourg.

List of Abbreviations

AFR	Aid for Research Training PhD and post-doc funding
BELSPO	Belgian Federal Science Policy Office
BERD	Business Expenditures for Research and Development
COST	European Cooperation in Science and Technology
CEPS/INSTEAD	Centre d'Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques / International Networks for Studies in Technology, Environment, Alternatives, Development
CNRS	National Center for Scientific Research
CVCE	Centre for the Virtual Knowledge of Europe
DFG	German Research Foundation
ERA	European Research Area
ERA-NET	European Research Area Network
ESA	European Space Agency
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU-27	European Union including 27 Member States
LCSM	Luxembourg Centre for Systems Biomedicine
FDI	Foreign Direct Investments
FEDER	Fonds Européen de Développement Régional
FNR	Fonds National de la Recherche
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HRST	Human Resources in Science and Technology
IBBL	Integrated Biobank of Luxembourg
ICSU	International Council for Science
IP	Intellectual Property
LCSB	Luxembourg Centre for Systems Biomedicine
MECE	Ministry of the Economy and Foreign Trade
MESR	Ministry of Higher Education and Research
NRF	National Research Fund
NRP	National Reform Plan
NRS	National research system
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development

PPM	Programme for Personalised Medicine
PPP	Public-private partnership
PRC	Public Research Centre
PRO	Public Research Organisations
R&D	Research and development
RDI	Research and Development and Innovation
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
SME	Small and Medium Sized Enterprise
SNSF	National Science Foundation
S&T	Science and technology
VC	Venture Capital

European Commission
EUR 25723 – Joint Research Centre – Institute for Prospective Technological Studies

Title: ERAWATCH COUNTRY REPORTS 2011: Luxembourg

Author(s): Susan Alexander, Ruth Bloomberg

Luxembourg: Publications Office of the European Union

2013 – 34 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series –ISSN 1831-9424 (online)

ISBN 978-92-79-28126-6 (pdf)

doi:10.2791/55247

Abstract
The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

LF-NA-25723-EN-N

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ISBN 978-92-79-28126-6

Publications Office